PERFORMANCE-BASED PRACTICAL DESIGN

Dynamic Part-Time Shoulder Use Triggers

105th Purdue Road School

Bastian Schroeder – Kittelson and Associates

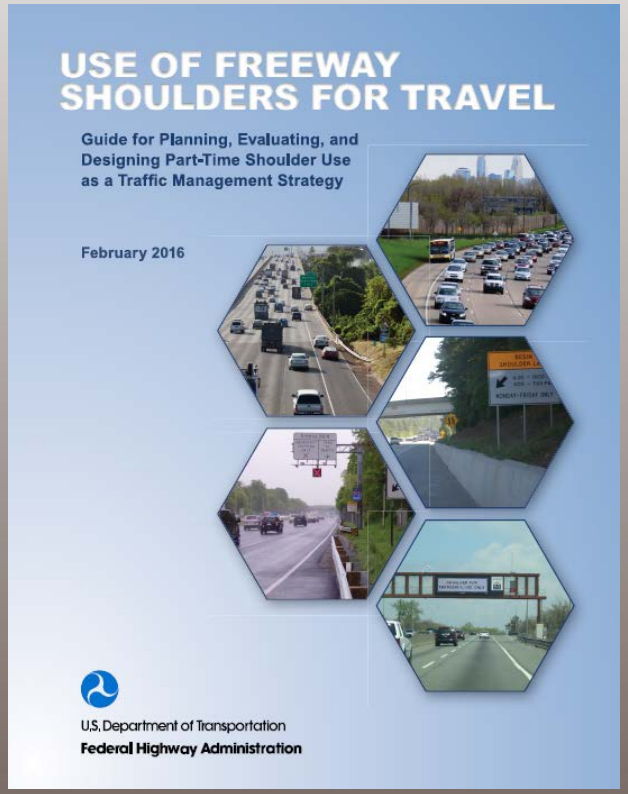
March 5, 2019

Office of Operations
Federal Highway Administration
1200 New Jersey Avenue SE
Washington, DC 20590

U.S. Department of Transportation
Federal Highway Administration

KITTELSON & ASSOCIATES

Overview



Triggers for Dynamic Part Time Shoulder Use (expected late 2019)

Performance Based Practical Design

- Modifying the traditional “top down, standards first” approach to a “design up” approach
- Project decisions are based on critical examination of geometric elements
- Utilizes relevant, objective data to inform decisions – engineering judgement
- Choices made to serve project priorities while trying to make cost effective decisions
- Project savings Benefit System Needs

Transportation Systems Management and Operations Strategies (TSMO)

- Work Zone Management
- Traffic Incident Management
- Service Patrols
- Special Event Management
- Road Weather Management
- Transit Management
- Freight Management
- Traffic Signal Coordination
- Traveler Information
- Ramp Management
- Managed Lanes
- **Part-Time Shoulder Use**
- Active Traffic Management
  - Dynamic Speed Limits
  - Dynamic Lane Assignment
  - Queue Warning
  - **Dynamic Part-Time Shoulder Use**

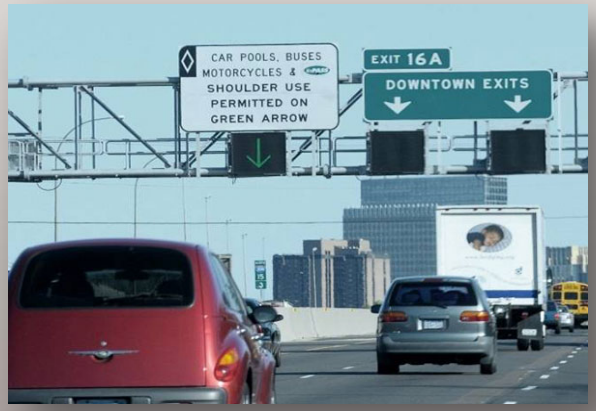
What is Part-Time Shoulder Use?

What is Part-Time Shoulder Use?

- **Various names**
  - Shoulder running
  - Hard shoulder running
  - Temporary shoulder use
  - Part-time shoulder use
- **Same meaning: use of the left or right shoulders of an existing roadway for travel during certain hours of the day.**
  - Transportation Systems Management and Operations (TSMO) strategy for addressing congestion and reliability issues
  - Preserves shoulder as shoulder during most hours of day

What is Part-Time Shoulder Use? (continued)

- It adds capacity only when needed
- It keeps the shoulder intact for most hours of the day
- Do what is physically and financially possible
  - Support decisions with analysis
- A decision to use the shoulder part-time may defer major and costly widening.



Source: Minnesota Department of Transportation

Source: Pace Bus

Types of Part-Time Shoulder Use

- Bus-on-Shoulder (BOS) – open only to buses, usually at driver's discretion
- Static part-time shoulder use – open to passenger vehicles during predetermined hours of operation
- Dynamic part-time shoulder use – open to passenger vehicles based on need and real-time conditions

Shoulder use typically implemented on freeways; but can be applied to arterials

Bus On Shoulder (BOS) in Minneapolis-St. Paul

Source: Metro Transit

Left-Shoulder Bus on Shoulder (BOS) in Chicago

Source: Pace Bus

Bus on Shoulder (BOS) on US 9 Arterial in New Jersey

Source: TCRP Report 151

Static Shoulder Use – US 2 in Washington State

Source: Google Maps

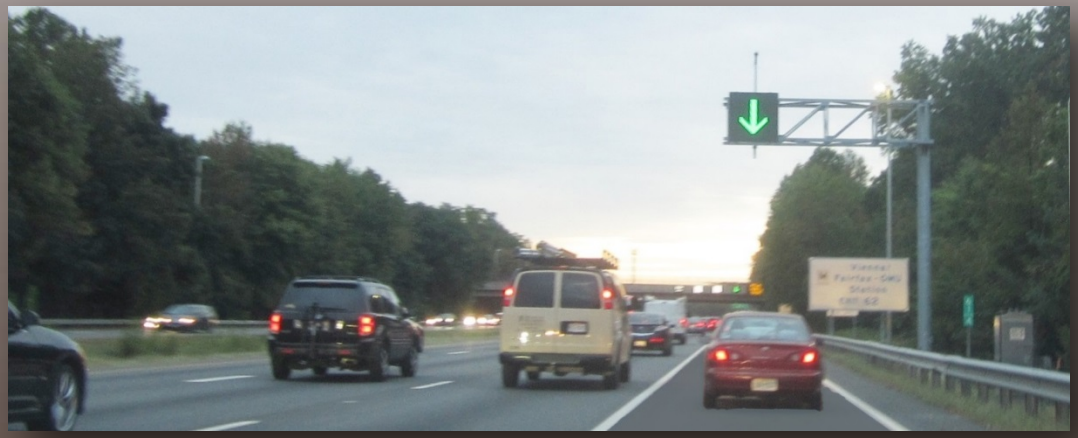
Static Shoulder Use – I-66 in Virginia (Made Dynamic in 2015)

Dynamic signs over shoulder; but fixed hours of operation.

Source: Virginia Department of Transportation

Dynamic Shoulder Use – I-66 in Virginia

Source: Virginia Department of Transportation



Source: Virginia Department of Transportation

Shoulder Use on I-70 Mountain Corridor, Colorado

Source: Colorado Department of Transportation

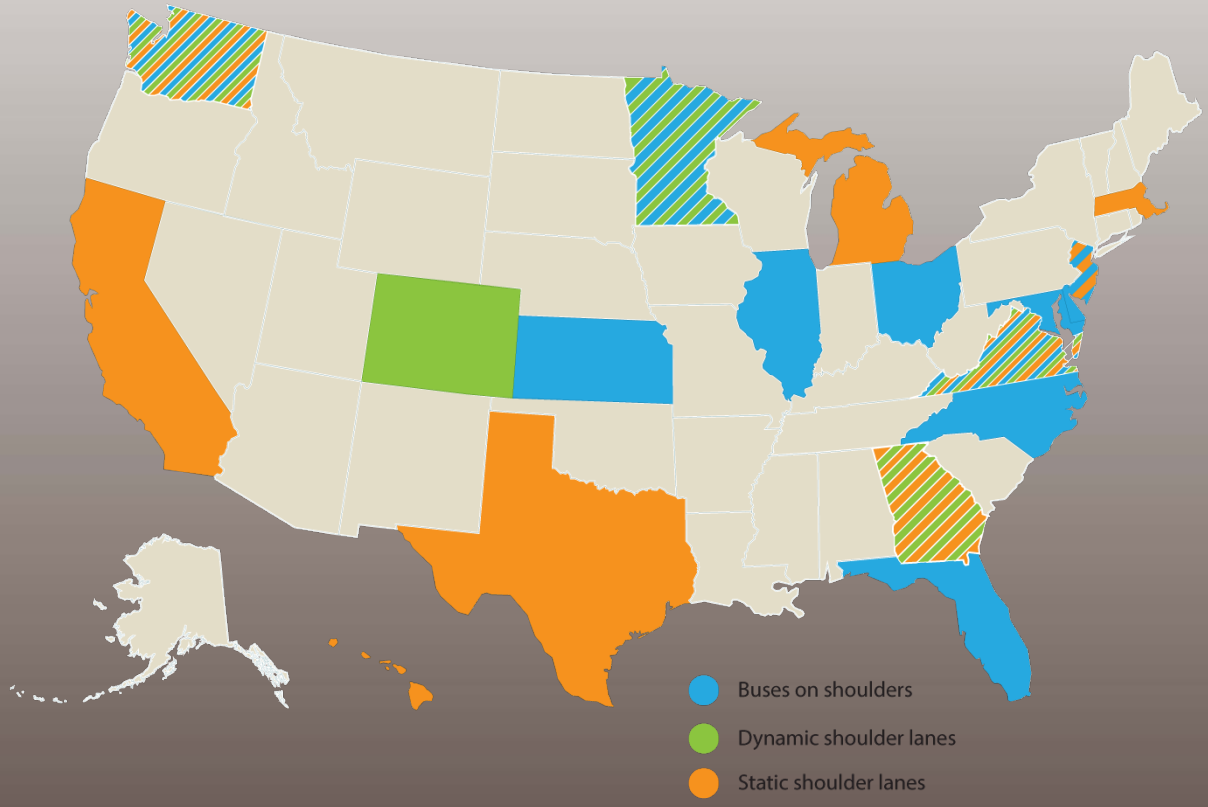
Source: Colorado Department of Transportation

Dynamic Shoulder Use – I-35W in Minneapolis

Source: Minnesota Department of Transportation

Where is Part-Time Shoulder Use in U.S.?

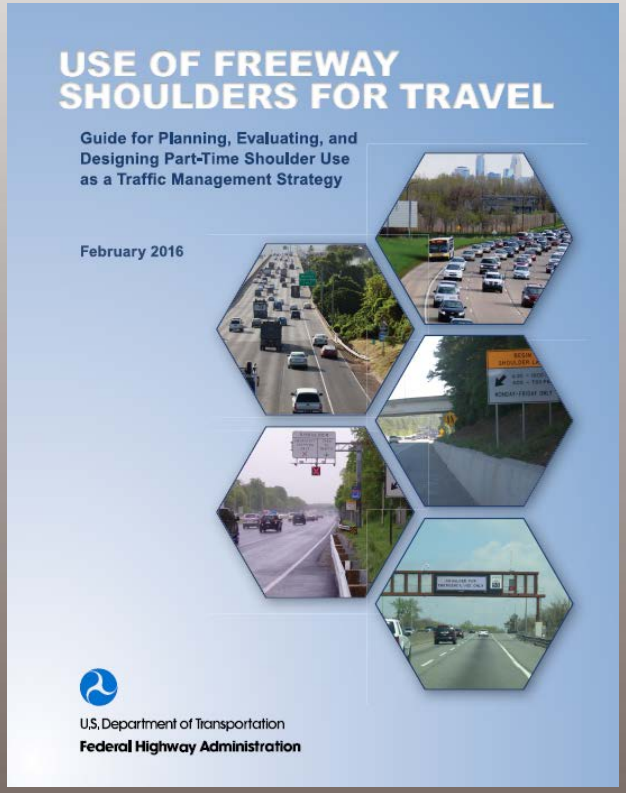
There are many international applications as well.



Source: Kittelson & Associates, Inc.

2016 Federal Highway Administration (FHWA) Guide

- A resource to assist State DOT's considering part time shoulder use.
- It is a guide, not a standard, directive or policy.
- Comprehensive
  - Limited information on operations: when to open and close shoulder



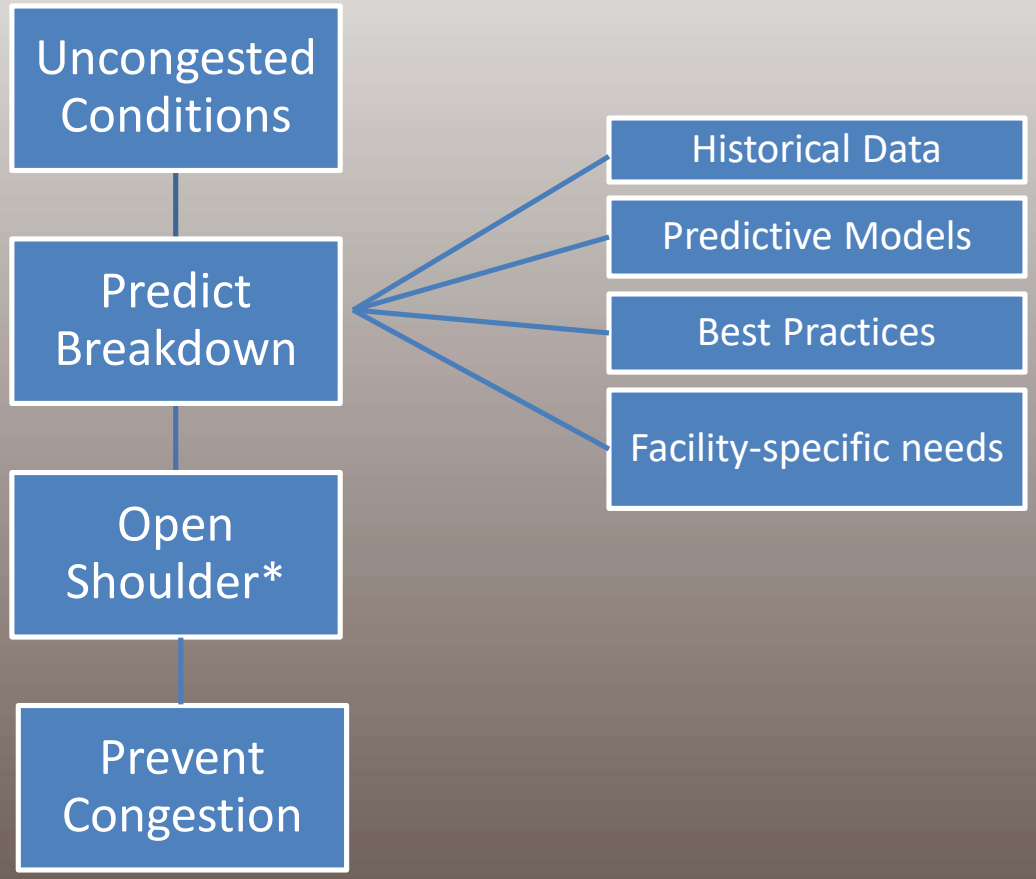
http://www.ops.fhwa.dot.gov/publications/fhwahop15023/index.htm

Current Research: “Triggers” for Dynamic Shoulder Use

Project Objectives

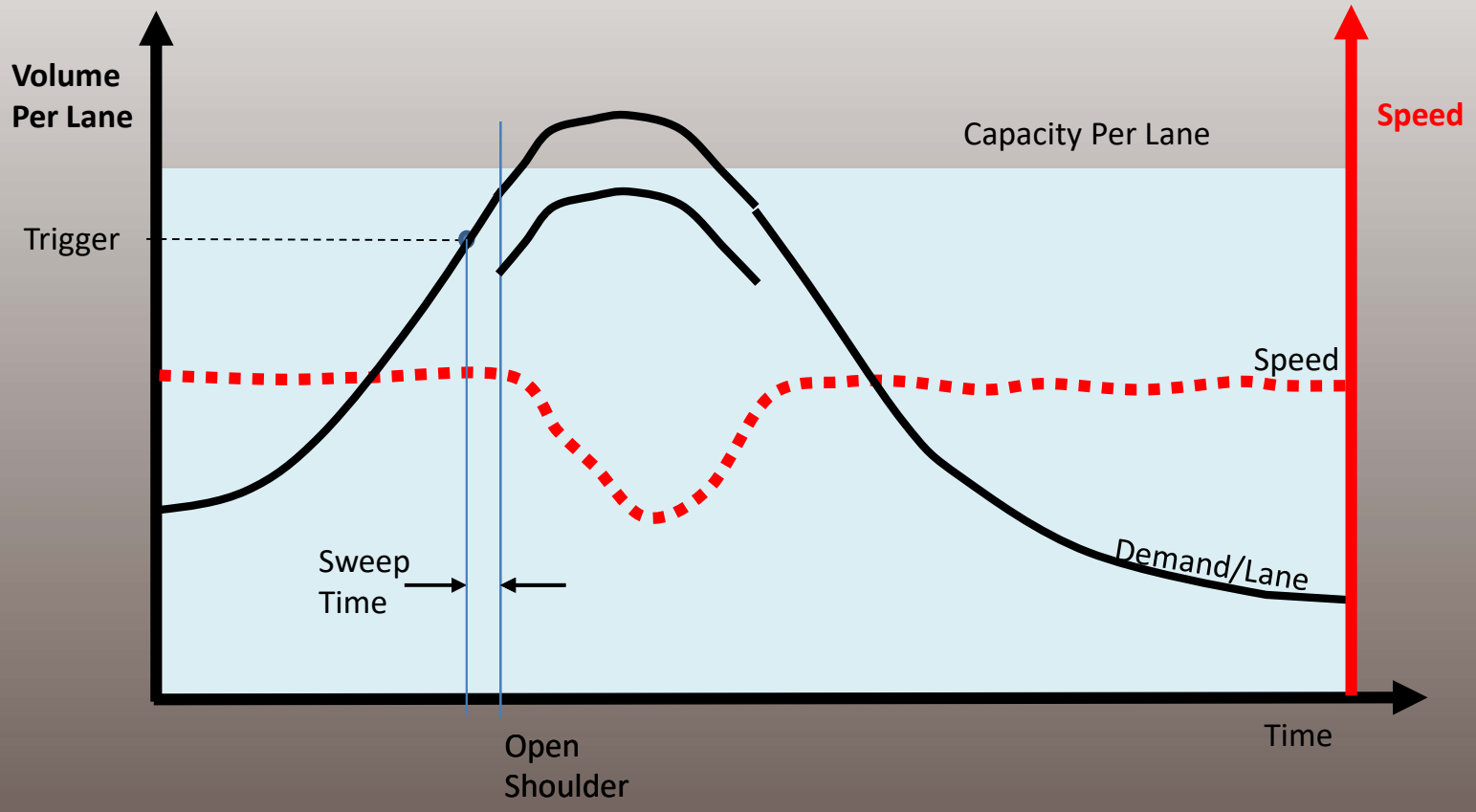
- Guide agencies to implement Dynamic Part-Time Shoulder Use (D-PTSU)
- Prepare internal FHWA white paper synthesizing current practices (complete)
  - Domestic and International
- Prepare guidebook document with “Triggers” for D-PTSU (expected late 2019)

Concept of Operational-Based Trigger



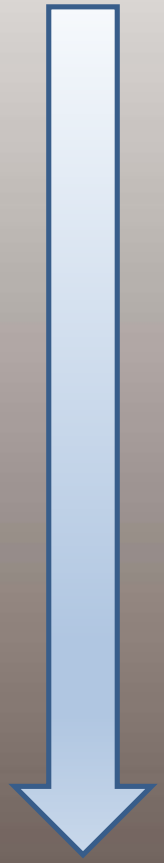
* Assuming there are no issues with maintenance, law enforcement, environmental conditions, etc.

Concept of Operational Trigger



Levels of PTSU

- Low level - Static
- Medium level(s)
- High level – Fully dynamic

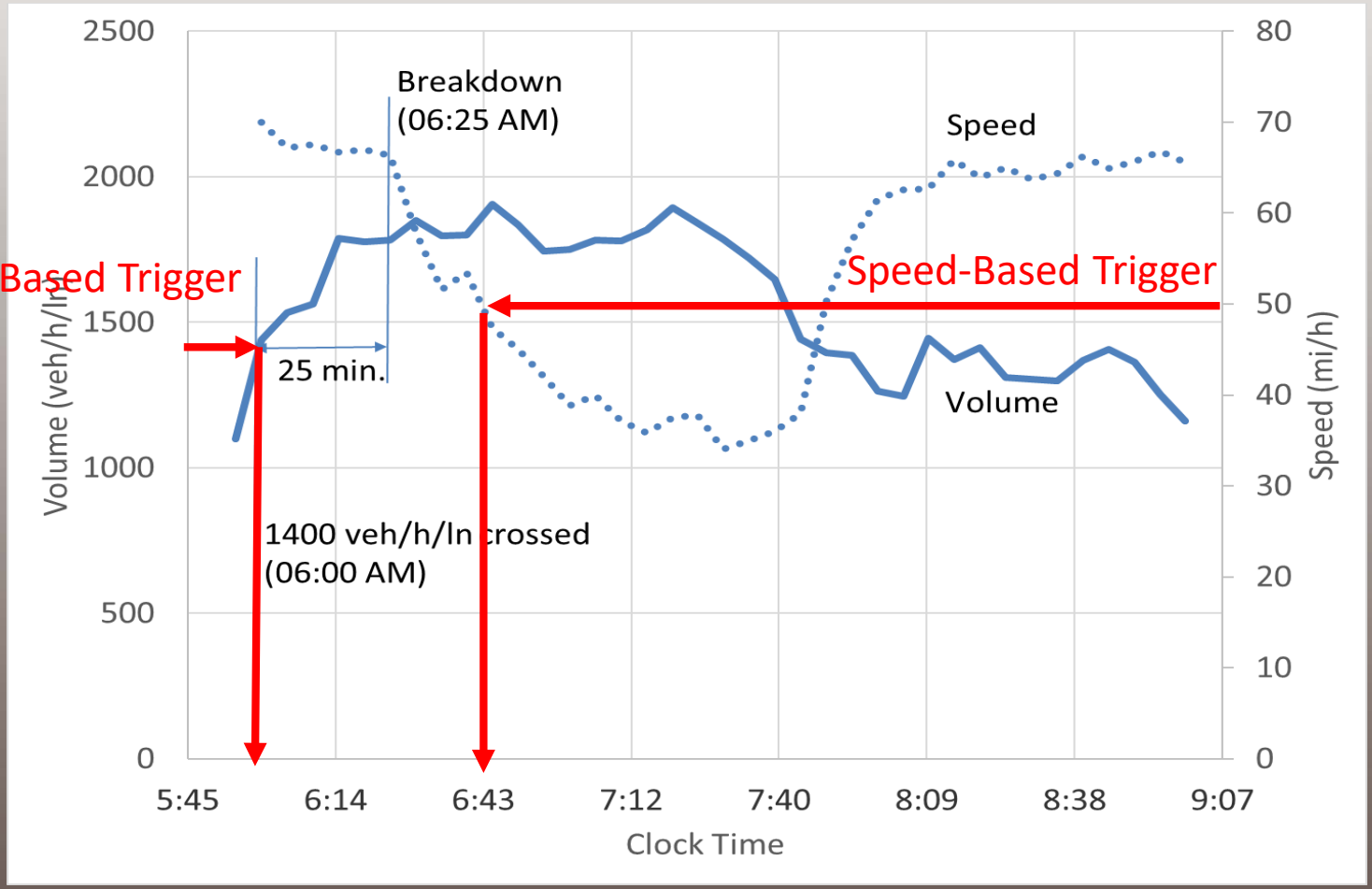


- Increasing real-time responsiveness to traffic
- Increasing Instrumentation and Automation
- Increasing agency capabilities/maturity

Types of Triggers

- Static (time-of-day) based operation
- Dynamic - Traffic volumes above/below a certain threshold.
- Dynamic - Vehicle operating speeds below/above a certain threshold.
- Combinations
- Triggers are used to both open and close the shoulder

Trigger Selection



Trigger Selection

- Variations in capacity
- Variability in Demand
- Sweep time
- Rate of increase in the traffic flow
- Geometry of the specific facility

Agency Questions (Use Cases)

- Would D-PTSU be an appropriate strategy in a location where no part-time shoulder use (even static) is currently in place?
- Should D-PTSU be considered in a location where static part-time shoulder use is in place?
- How can an agency better optimize the operation of an existing D-PTSU installation?

Analysis Approaches

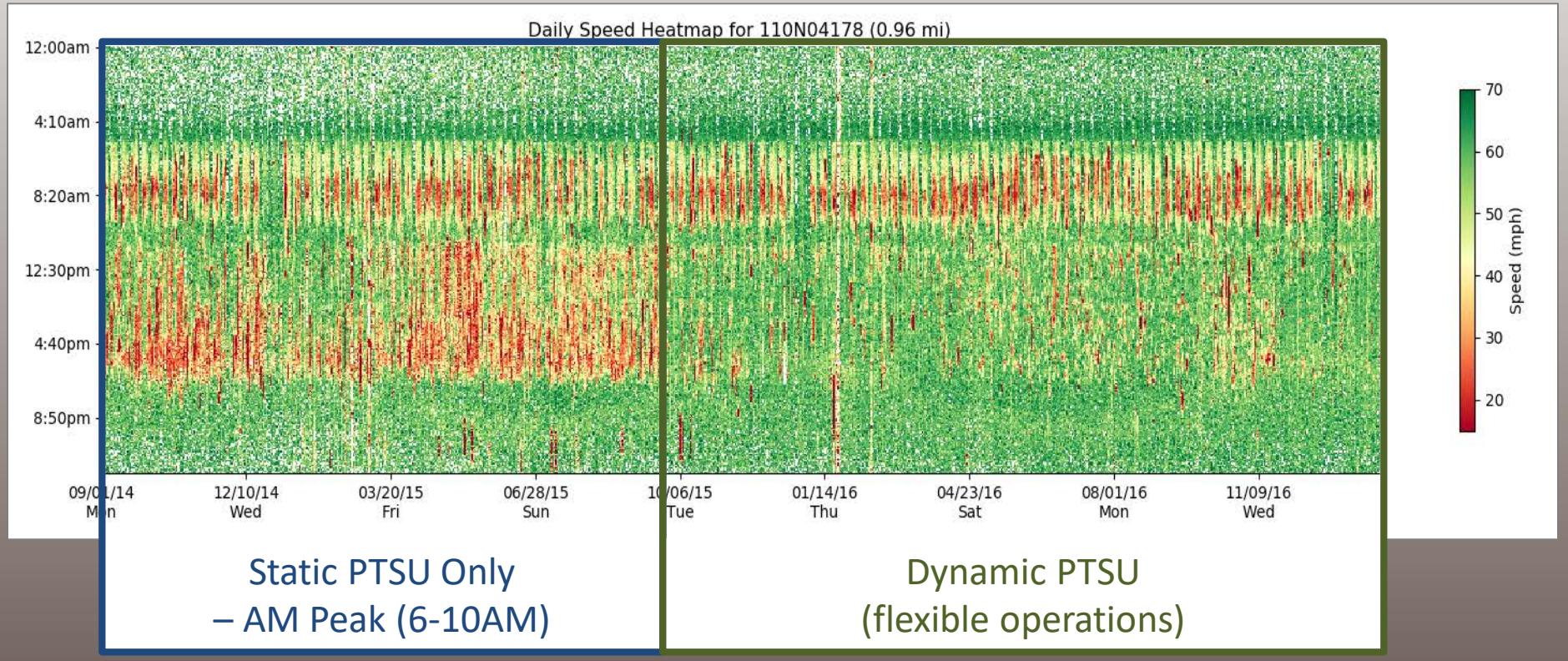
- **Demand-to-Capacity Patterns**
  - Sensor Data
- **Empirical Performance Data**
  - Probe Data
- **Macroscopic Trigger Optimization**
  - HCM Modeling
- **Microscopic Trigger Refinement**
  - Microsimulation
- **Monitoring and Adjustment**
  - Real Time

Demand-to-Capacity Patterns

Base Number of Lanes	Base Capacity (pc/h/ln)	Capacity with PTSU added* (pc/h/ln)**	Ratio of PTSU vs. Base → PTSU d/c** Ratio Target
2	4,000-4,400	5,600-6,000	1.40 – 1.36
3	6,000-6,600	7,600-8,200	1.27 – 1.24
4	8,000-8,800	9,600-10,400	1.20 – 1.18

* Assumes shoulder capacity of 1,600 pc/h/ln
**d/c = demand to capacity (ratio). pc/h/ln = passenger cars per hour per lane. PTSU = part-time shoulder use.

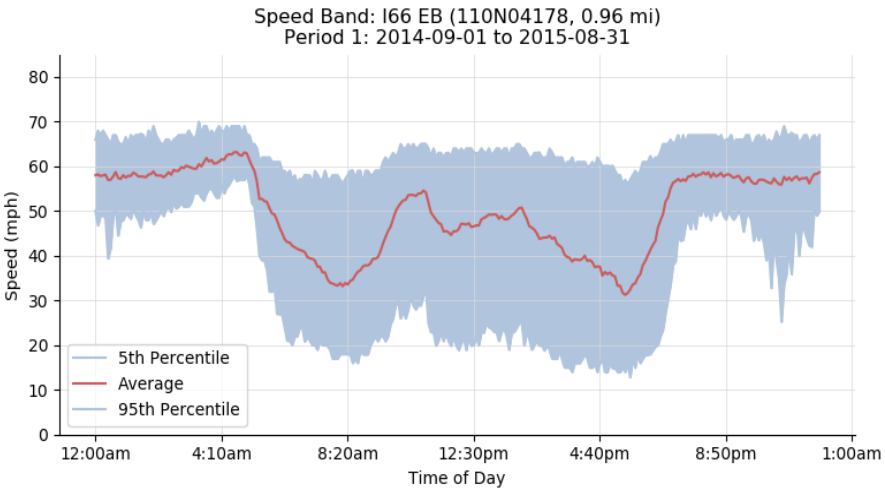
Empirical Performance Data (Example I-66)



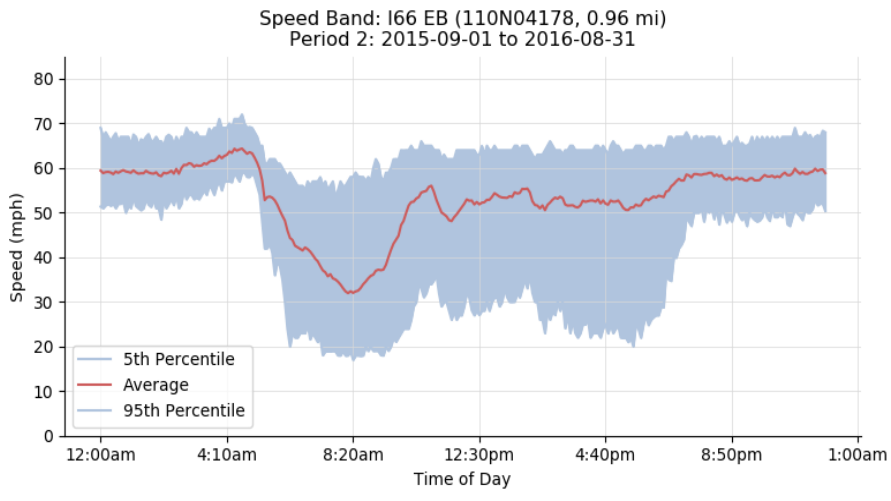
Static PTSU Only – AM Peak (6-10AM)

Dynamic PTSU (flexible operations)

Before and After Performance (Example I-66)

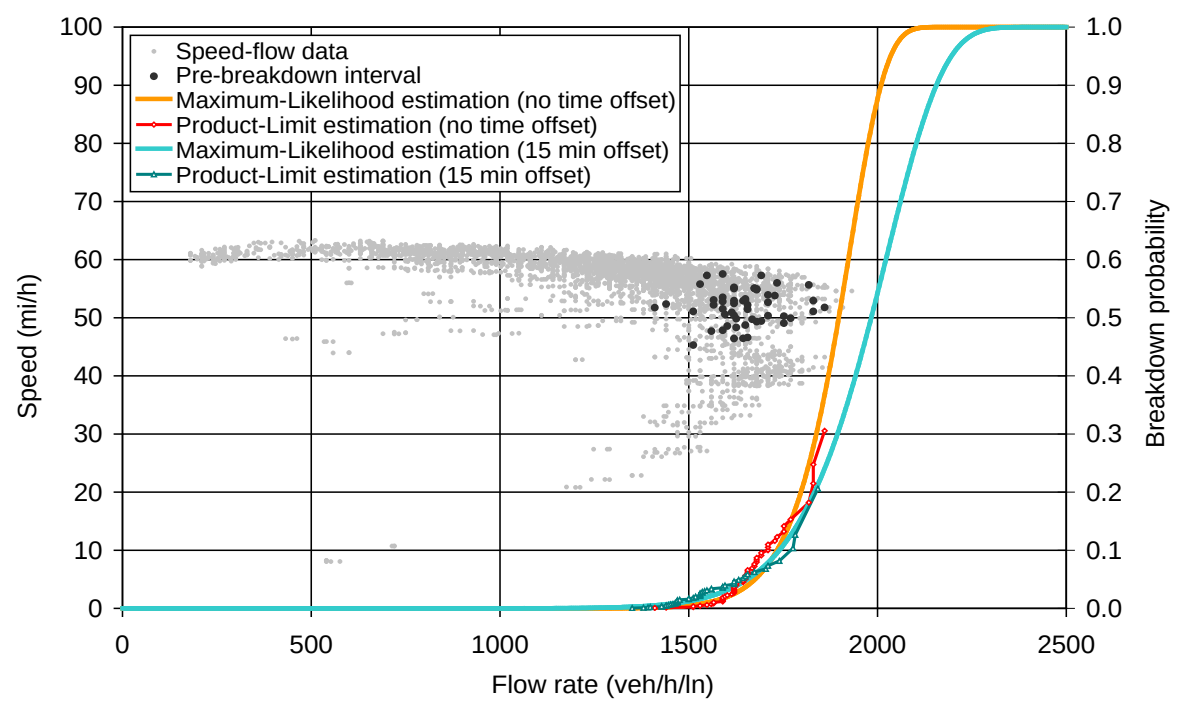


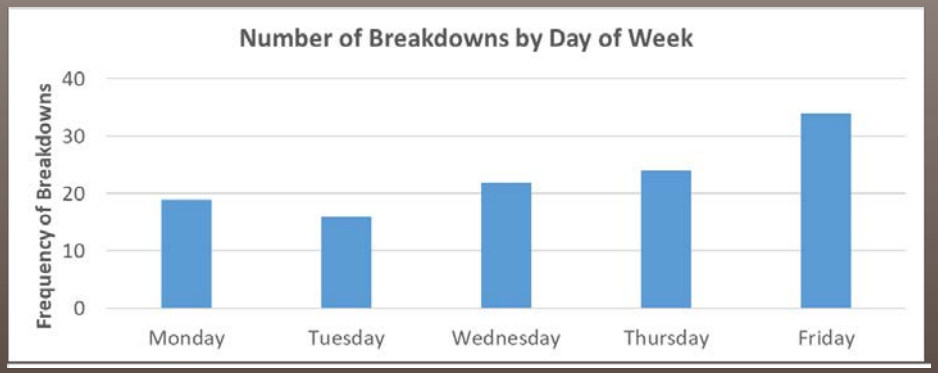
Static PTSU Only
– AM Peak (6-10AM)

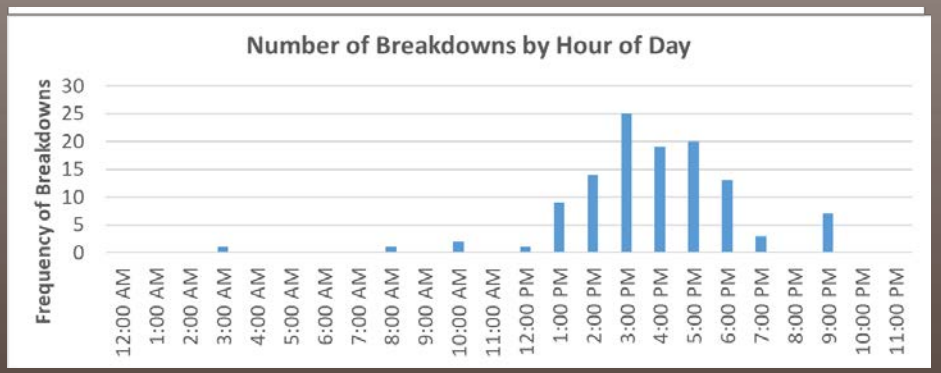


Dynamic PTSU
(flexible operations)

Empirical Performance Data - Breakdown Distribution







Trigger Summary

- Breakdowns are frequent and predictable (e.g. every morning between 7am and 9am, but no breakdowns other times),
  - **Fixed time-of-day trigger may sufficient**
- Breakdowns are seasonal (not a daily occurrence), variable (breakdown in the mornings but also in some afternoons, and sometimes on the weekends), or random (result of incidents, weather, special events)
  - **Speed-based trigger may be most adequate**
- Breakdowns are frequent and reasonably predictable based on cyclical traffic patterns (e.g. breakdown every morning peak),
  - **Volume-based trigger may be appropriate**
- **Combination of Triggers cover multiple applications**

Finding the Sweet Spot

- Opening the shoulder too early results in increases in capacity before it is needed, resulting in potentially higher speeds, and potentially reduced safety.
- Opening the shoulder too late may result in congestion and potentially reduced safety
- A trigger volume that is set too low can result in false positives; i.e., traffic volumes are increasing but will never reach capacity.

Project Timeline

- Technical work completed in early 2019
- Webinar in mid-2019
- Publication in late-2019

QUESTIONS?

Contact Information

- Jim Hunt jim.hunt@dot.gov
- Greg Jones GregM.Jones@dot.gov
- Pete Jenior pjenior@kittelson.com
- **Bastian Schroeder bschroeder@kittelson.com**
- David Hale david.k.hale@leidos.com